Presentation description of LAPC paper / poster entitled

Dielectric Resonator Antenna Design For UWB Applications

F. Elmegri, A. H. Al-Qaysi, C.H. See, R.A. Abd-Alhameed, C. Zebiri and P.S. Excell

This presentation describes two designs for Dielectric Resonator Antennas (DRA) that are suitable for ultra wideband (UWB) communication system applications.

Following the introductory part, title and summary, **slide 4, 5 and 6** presented a brief introduction about the DRA.

Slide 7 shows description for the first proposed antenna. This antenna is constructed by rectangular ceramic block with dimensions 6.00 mm × 9.00 mm × 6.00 mm, FR4 substrate with relative permittivity of 4.5 with (30 × 21 × 0.8 mm^3), feed line of 18 mm × 1.5 mm at the end a T-shaped element is used to excite the DR

In **slides 8, 9 and 10,** a parametric study for three sensitive parameters (DR_W, DR_L and T_L) are shown to understand the reflection coefficient results as a function of the DRA geometry.

Slides 11and 12 show the simulation results using two simulations software's which are Ansoft HFSS and Semcad, S11 parameter of the proposed antenna is better than 10dB. As can be seen, the antenna is operating from 3.1 to 5.5 GHz.

Slide 13 and 14 presents the simulated Far Field radiation patterns results of the proposed antenna, at two planes, i.e. E-plane (XZ- plane) and H-plane (XY-plane) for three operating frequencies, i.e. 3.1 GHz, 4.5 GHz and 5.5 GHz, which are chosen to cover the entire operating band. As can be clearly seen, the antenna exhibits consistent onmi-directional patterns across of the operating band

Slide 15 shows description for the second proposed antenna which is constructed using ceramic block of ε_r =9.4 with cylindrical shape of dimensions 6.00 mm × 9.00 mm × 6.00 mm, FR4 substrate with relative permittivity of 4.5 with (23 × 23 × 0.8 mm^3), flipped L-shaped feed line of 10.5mm × 6.5mm×1.5 mm and a T-shaped slot .

Slides 15-22 summarize the parametric study for seven sensitive parameters (S_L, *y, sw, x, wf2, lf2* and w_{f1}) against the variations of the reflection coefficient results as a function of the DRA geometry.

Slides 23 and 24 show the simulation results using CST microwave studio suit 2011. As can be seen, the antenna is operating from 6.27 to 11.69 GHz (60%) at the reflection coefficient $|S_{11}|$ better than -10 dB.

Slide 25 presents the simulated E-field radiation patterns of the proposed antenna at (Ø=90) and (Ø =0) for two operating frequencies, i.e. 6.77 GHz and 11.0 GHz, which shows that the proposed antenna exhibits broadside radiation.

Slide 26 presents conclusions about the two proposed DRA antennas.

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Summary

A compact dielectric resonator antennas have been designed for ultra wideband (UWB) communication system applications. The first antenna comprises of a rectangular dielectric resonator of low permittivity ceramic block, with a dielectric constant of 9.4, and modified T-shaped feed network includes a 50 ohm microstrip line to achieve strong coupling, and some bandwidth enhancement. The antenna performance is simulated and measured over a frequency band extending from 3.1GHz to 5.5GHz; the impedance bandwidth over this interval is 55.8% with VSWR < 2, making the antenna suitable for UWB applications.

Summary(Cont.)

The second antenna is balanced cylindrical dielectric resonator antenna fed through T- shaped aperture with modified ground plane designed for wide band applications. The antenna performance is simulated and measured over a frequency band extending from 6.27GHz to 11.69GHz; the impedance bandwidth over this interval is 60% with VSWR < 2, making the antenna suitable for wide band applications.

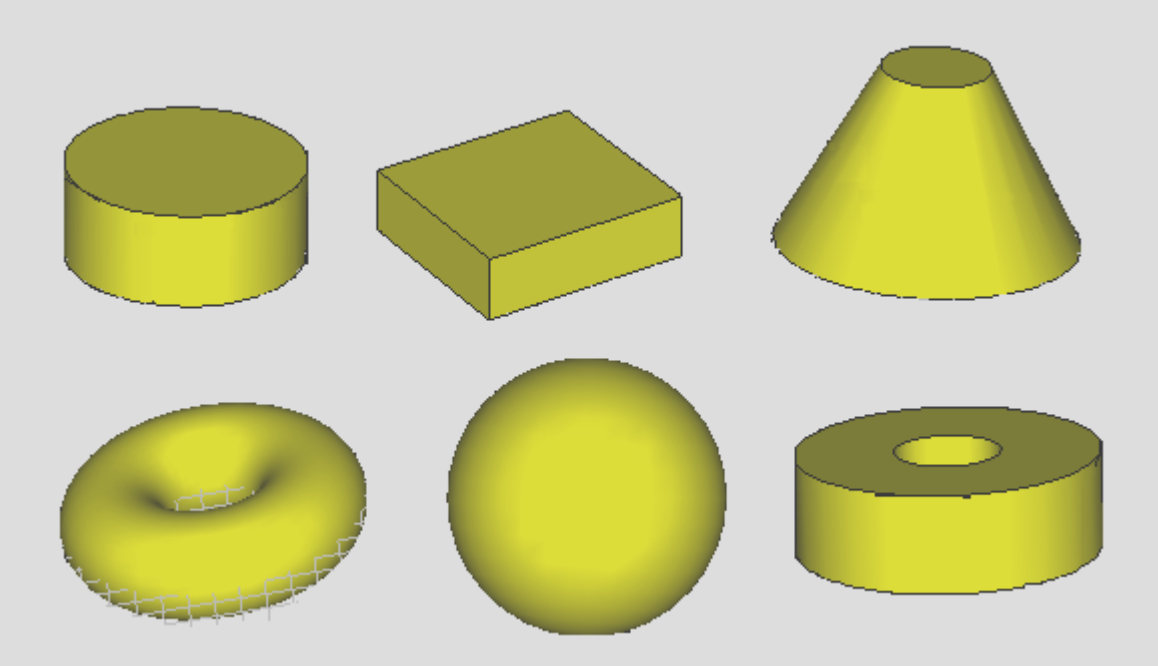
DRA Outline

Dielectric Resonator Antenna has been widely used in wireless communications technology due to the following reasons:

- Dielectric materials can have low dielectric loss and the absence of metallic surfaces also reduces conduction losses.
- A dielectric resonator antenna can have small sizes.
- High radiation efficiencies above (*95%)*.
- Wide bandwidth and high power capability.
- The far field radiation pattern is a characteristic of the resonating modes.

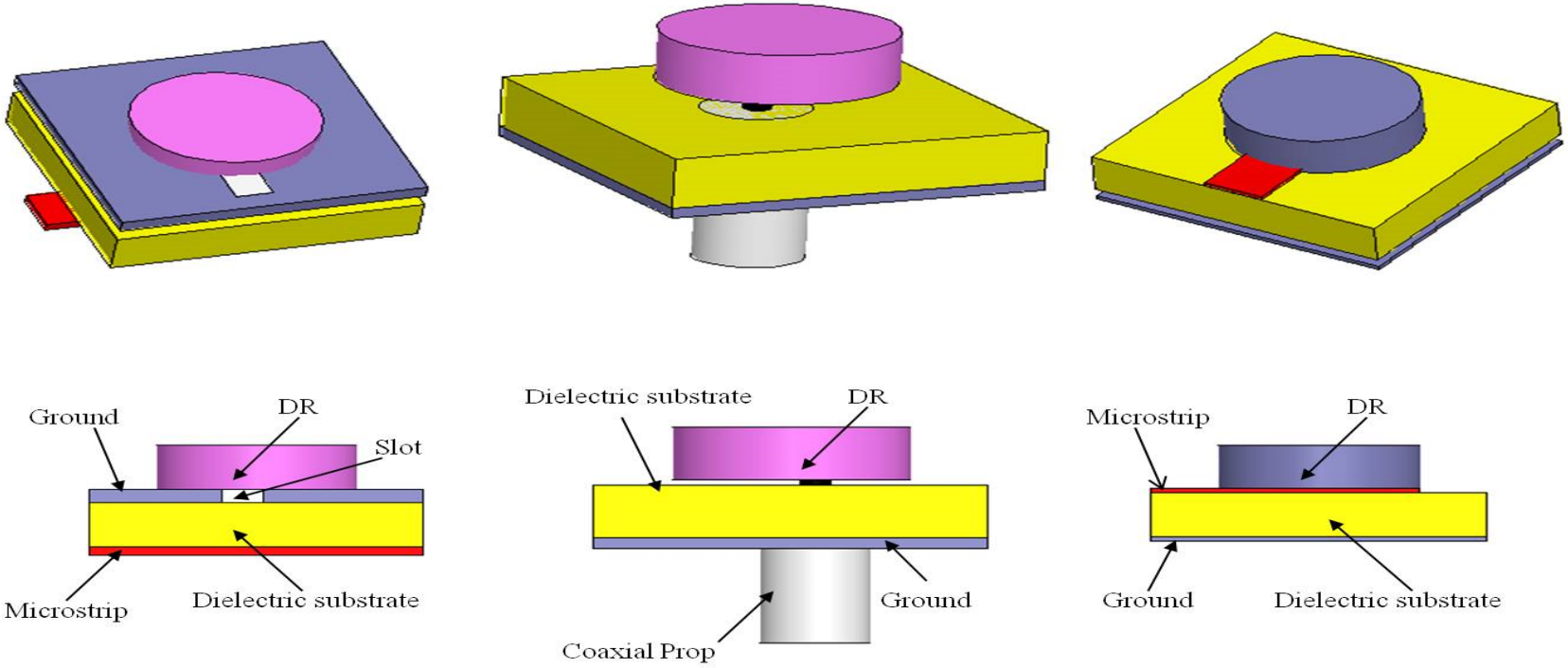
Introduction to DRAs cont.

- ***DRA can be easily designed in any 3D different shape***



Introduction to DRAs (cont.)

- ***DRA can be feeding by several feeding methods;***

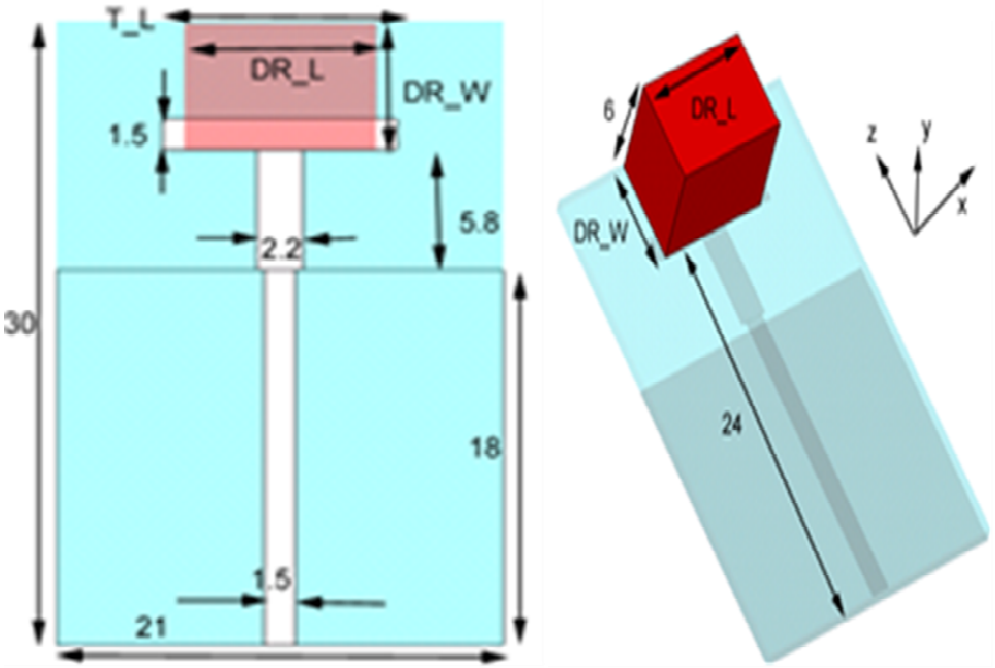


(a) Micro-slot (b) Coaxial Probe (c) Microstrip

ANTENNA 1 DESIGN CONCEPT

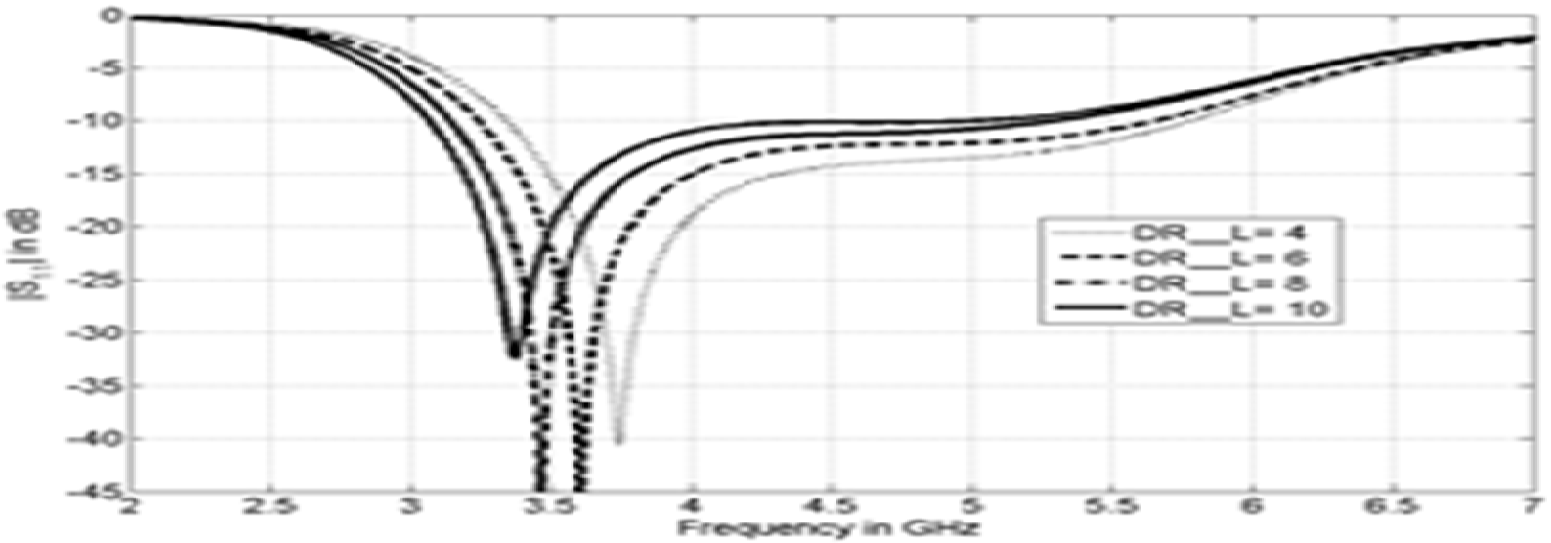
Description:

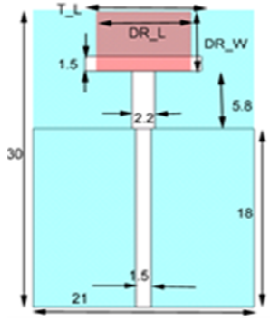
- *The proposed antenna is constructed by rectangular ceramic block with dimensions 6.00 mm × 9.00 mm × 6.00 mm, FR4 substrate with relative permittivity of 4.5 with (30 x 21x0.8 mm3), feed line of 18 mm × 1.5 mm at the end a T-shaped element is used to excite the DR , as shown in Fig.*



Parametric Study Results

- A parameter study is needed to understand the antenna return loss as a function of the DRA geometry. Three sensitive parameters, i.e. DR_W, DR_L and T_L
- Changing the length of (DR_L) from 4 mm to 10 mm with increment of 2 mm, the operating frequency band gradually moves to the lower band and meeting the design goal.

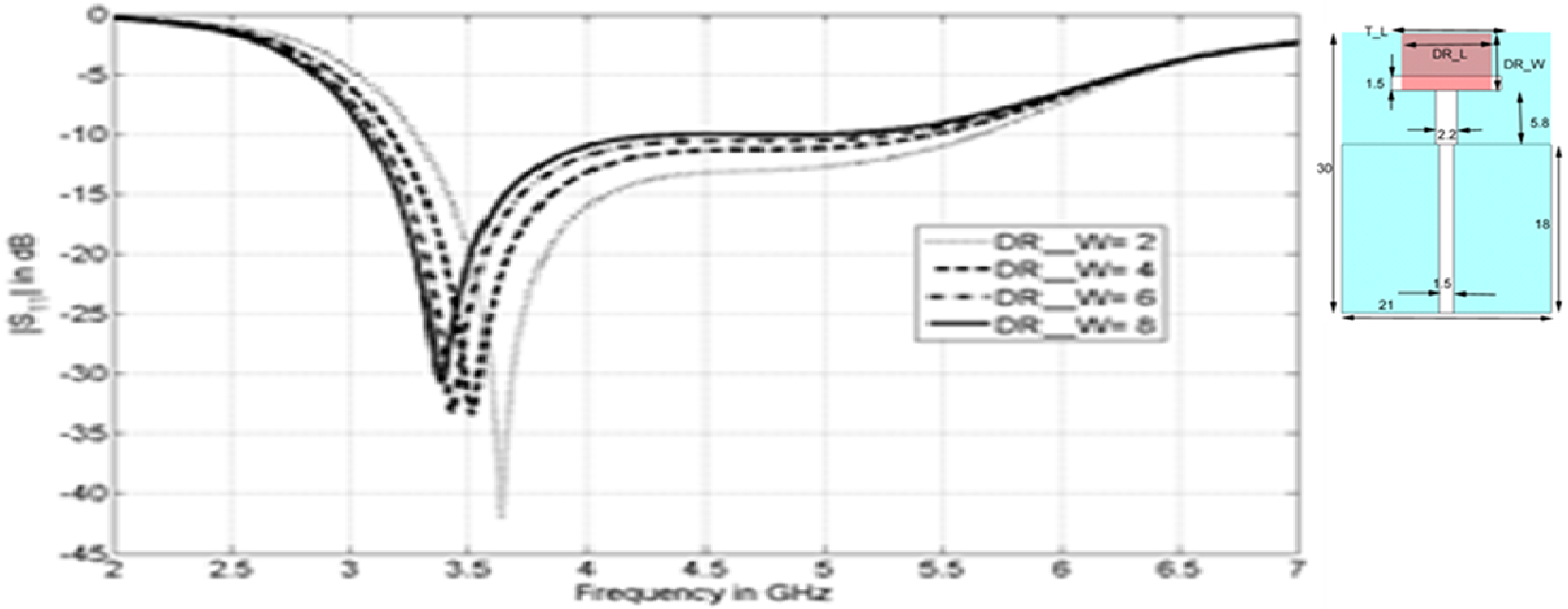




Length of DR (DR_L)

Parametric Study Results (Cont.)

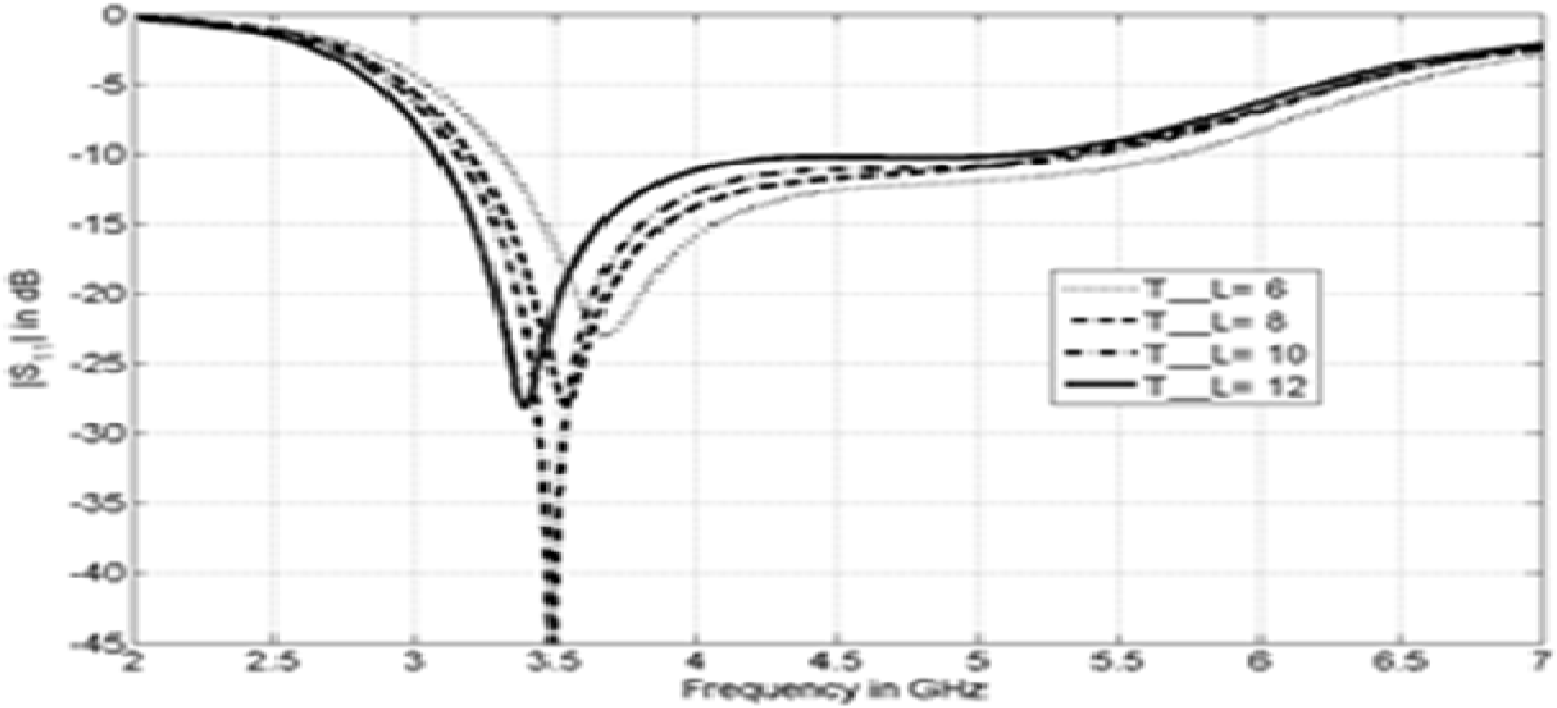
- Changing the length of (DR_W) from 2 mm to 8 mm with increment of 2 mm, where as DR_W should be selected between 6 to 8 mm

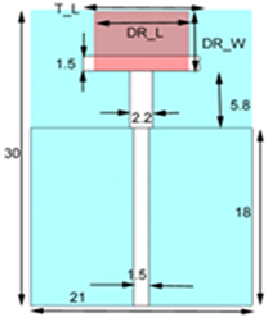


Width of DR (DR_W)

Parametric *Study Results cont.*

Changing the length of (T_L) from 6 mm to 12 mm with increment of 2 mm, where as T_L should be selected between 6 to 8 mm



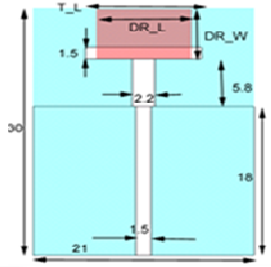


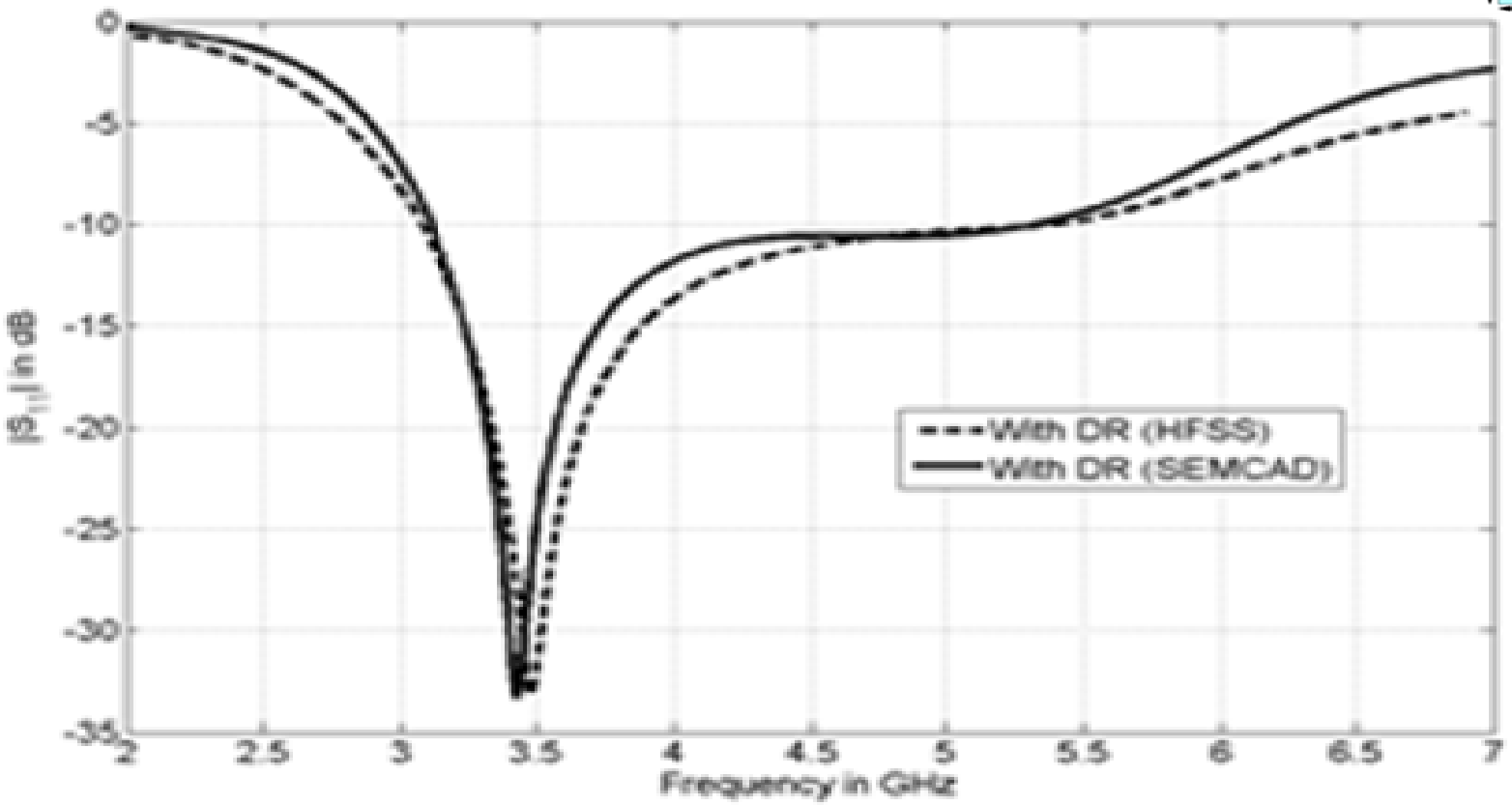
Length of T-strip (T_L)

Results And Discussion

- The simulated results, two software packages, i.e. Ansoft HFSS and SEMCAD, were used for comparison. The obtained reflection coefficient |S11| of the proposed antenna from these packages are shown in Fig. It should be noted that 9 mm, 6 mm, 11 mm for DR_L, DR_W and T_L, were selected in the design model. As can be seen, the antenna is operating from 3.1 to 5.5 GHz at the reflection coefficient |S11| better than -10 dB.

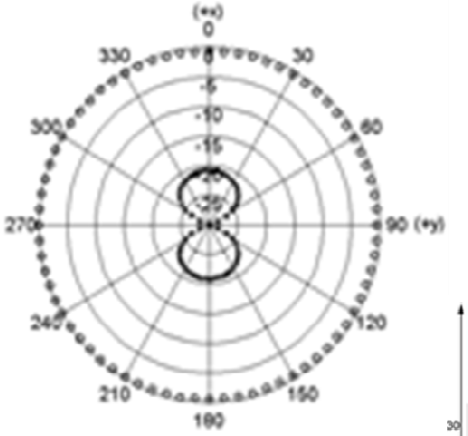
Simulated Return Loss

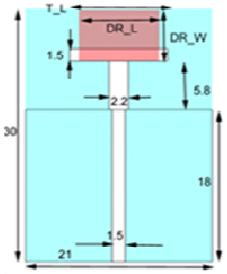


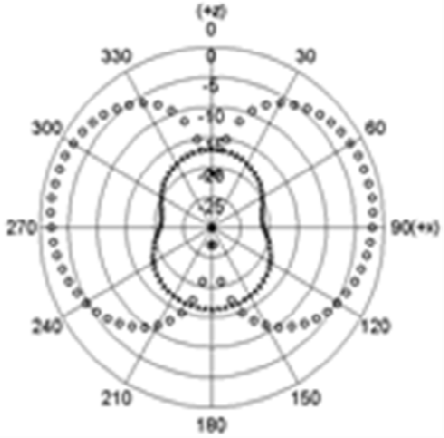


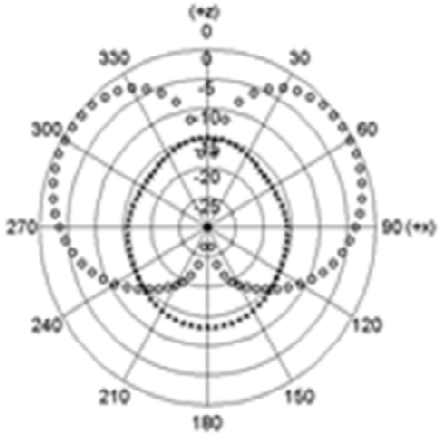
Far Field Simulation

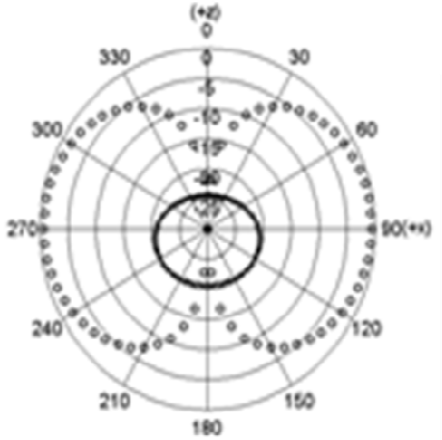
Simulated radiation patterns of the proposed antenna. at two planes, i.e. E-plane (XZ- plane) and H-plane (XY-plane). Three operating frequencies, i.e. 3.1 GHz, 4.5 GHz and 5.5 GHz, were chosen to cover the entire operating band. As can be clearly seen, the antenna exhibits consistent omni-directional patterns across of the operating band.

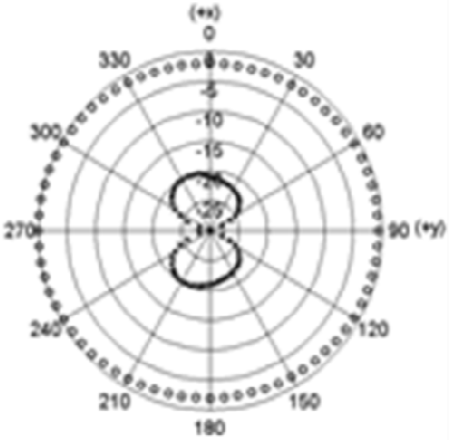


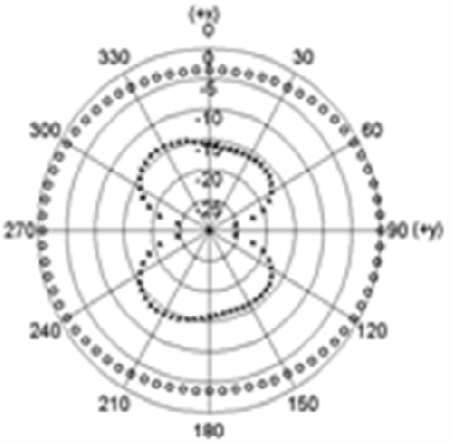












3.1 GHz

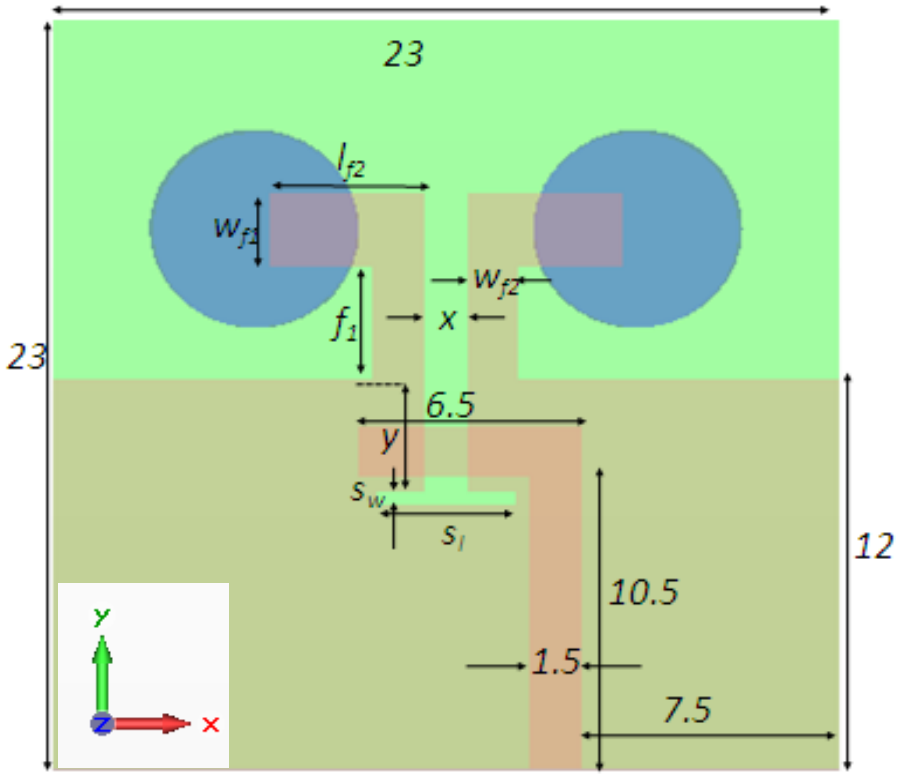
4.5 GHz

5.5 GHz

ANTENNA 2 DESIGN CONCEPT

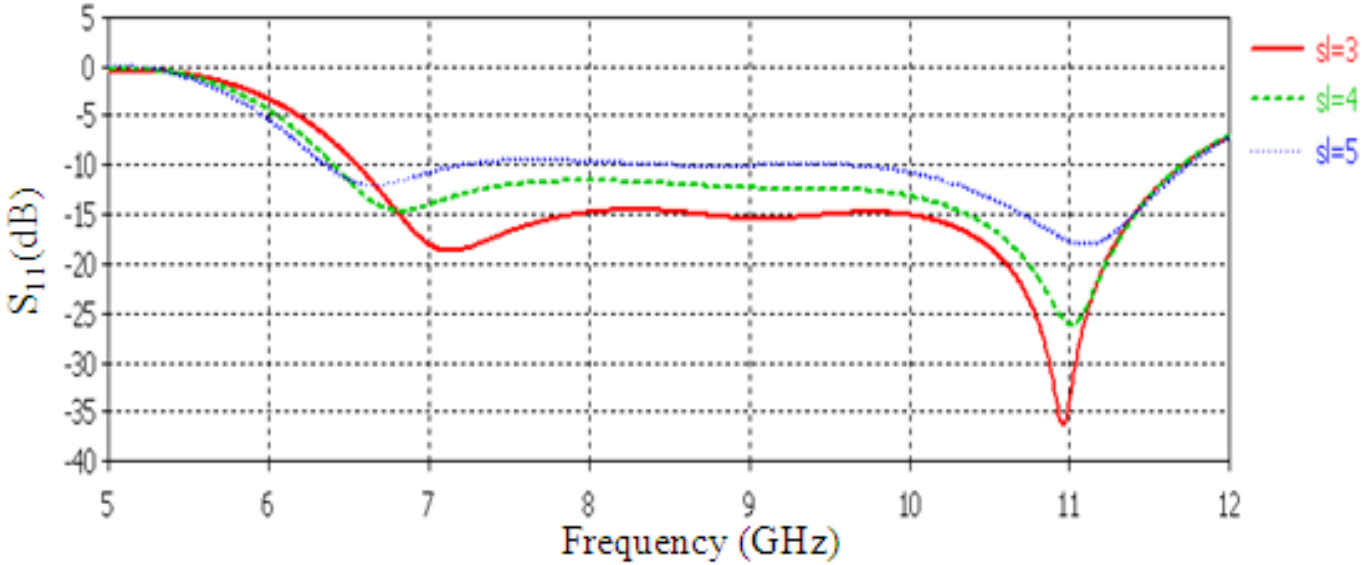
Description:

- The proposed antenna is constructed by dual segment cylindrical ceramic block of low permittivity with dimensions 6.00 mm×9.00mm×6.00mm,FR4 substrate with relative permittivity of 4.5 and loss tangent of 0.017 with(23 x 23x0.8 mm^3), flipped L-shaped feed line of 10.5 mm ×6.5mm × 1.5 mm , ground plane with (23 x 12mm^2) ended with two flipped L-shaped strips as shown in Fig.



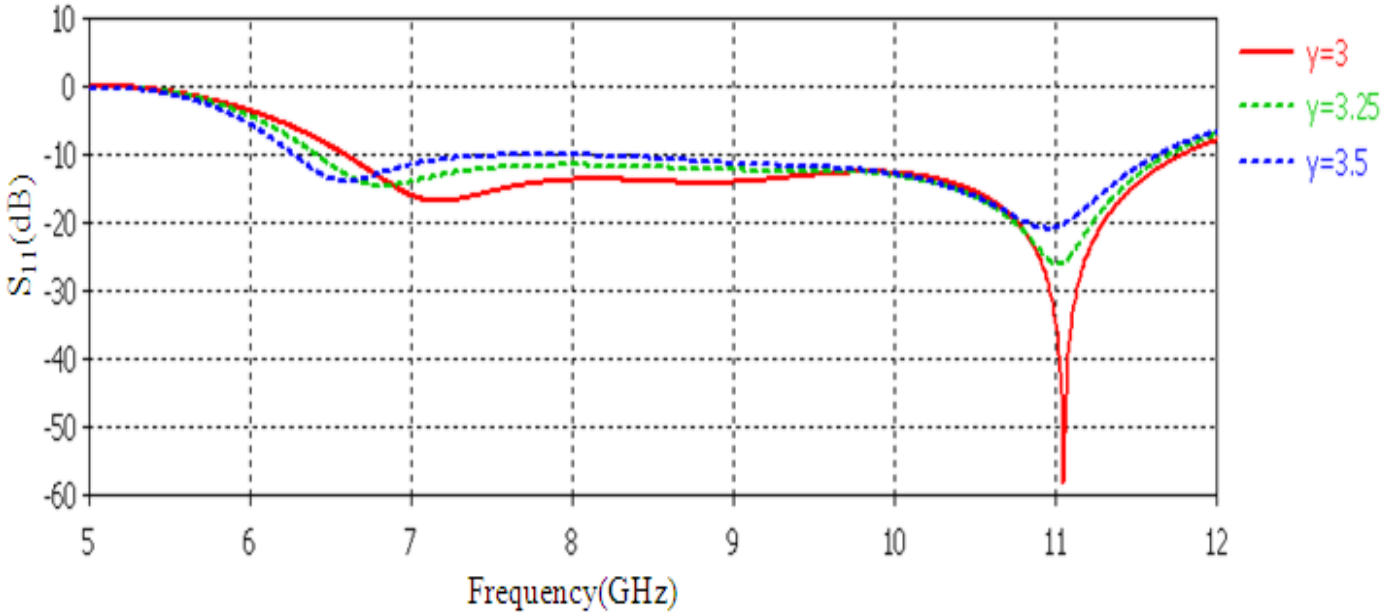
Parametric Study Results

- A parametric study is carried out to investigate the effects of various parameters on the response of proposed antenna. The parametric analysis is carried out while holding the remaining parameters with the dimensions presented in Figure above.
- Simulated effects on reflection coefficient in terms of various horizontal slot lengths s_l (3-5)mm. s_l=4mm is chosen as optimum value.



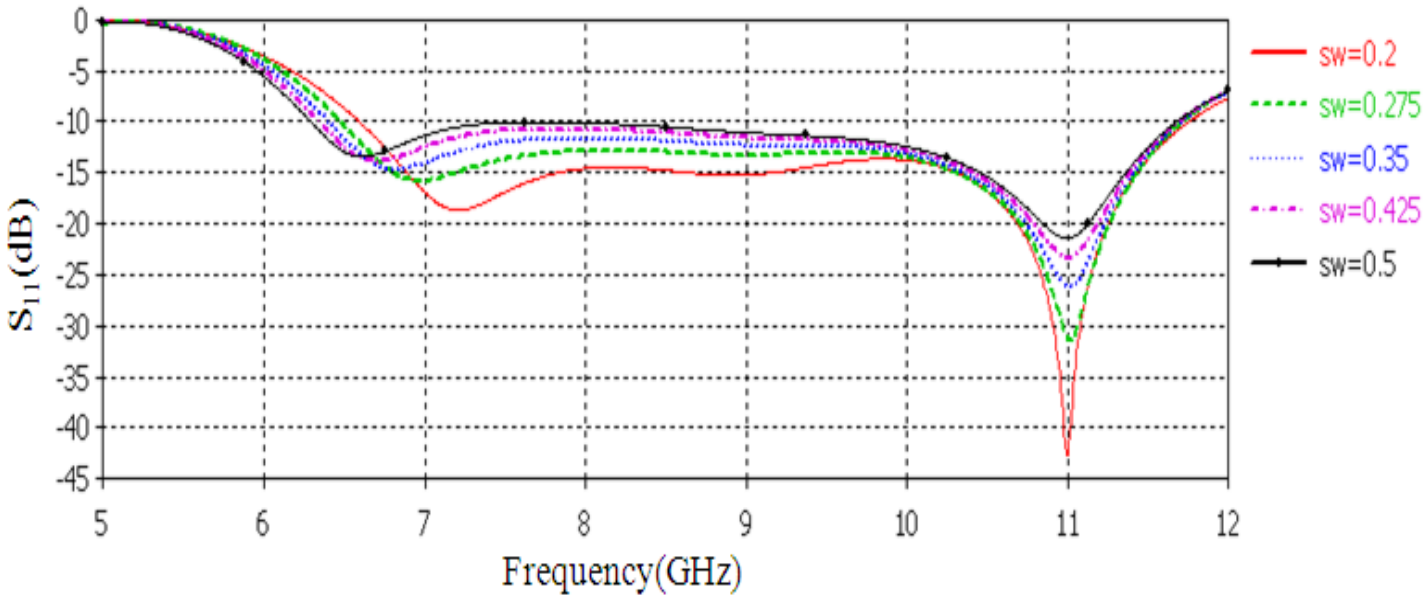
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for various vertical slot lengths *y*(3.0-3.25)mm. *y*=3.25mm is the optimum



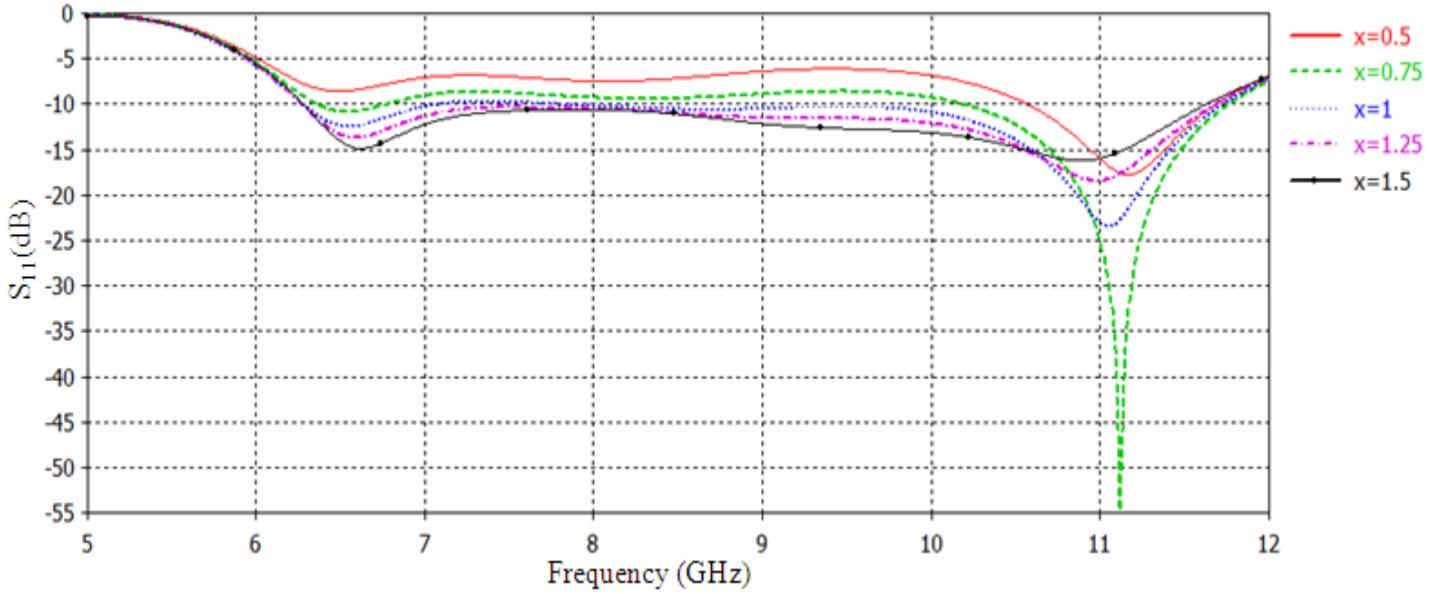
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for various horizontal slot width s_w (0.2-0.5)mm . s_w=0.35mm is optimum.



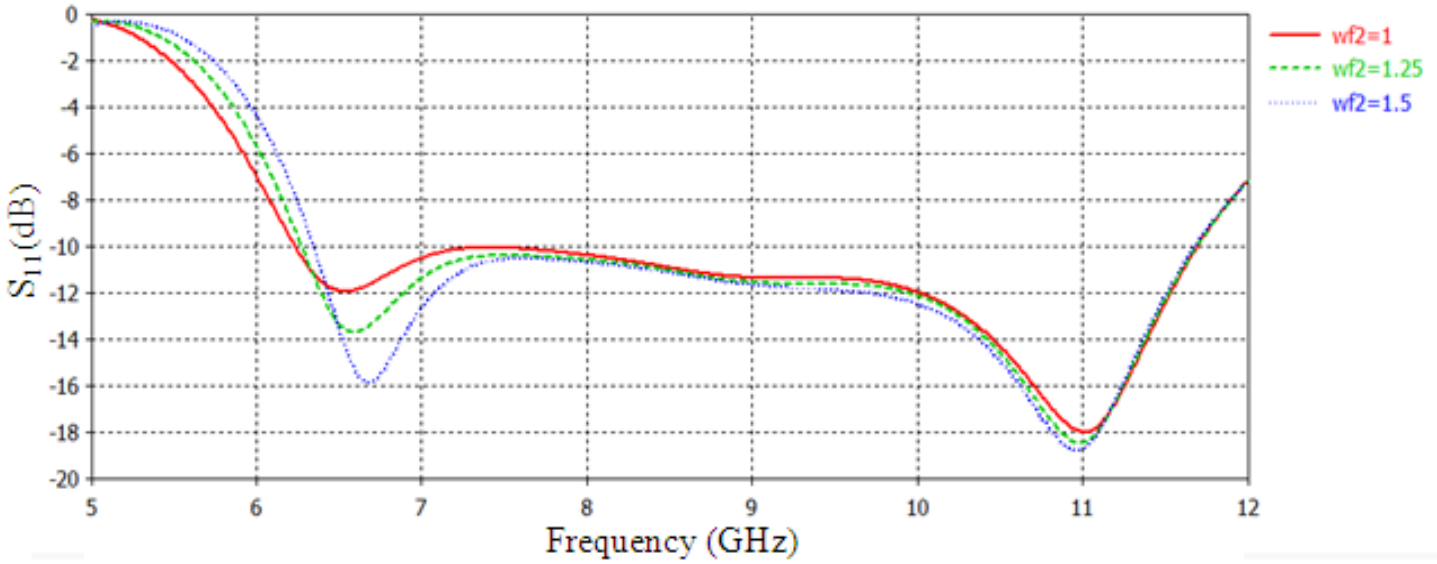
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for different vertical slot width *x* (0.1-1.5)mm



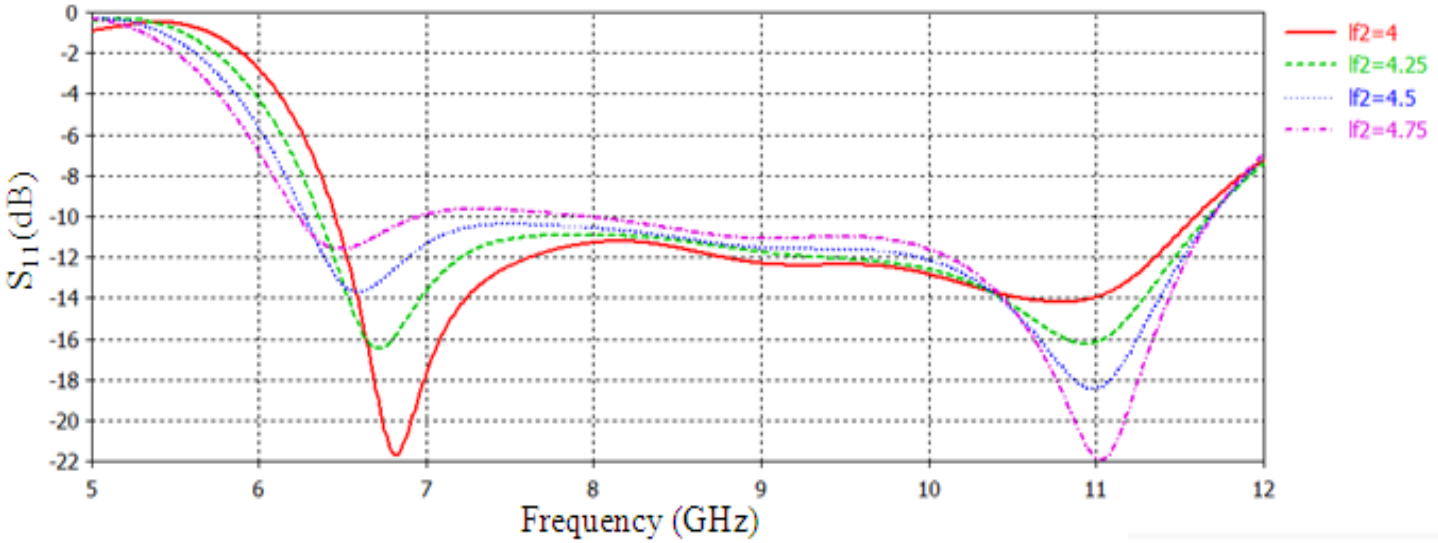
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for different vertical slot width W_{f2} (1.0-1.5)mm



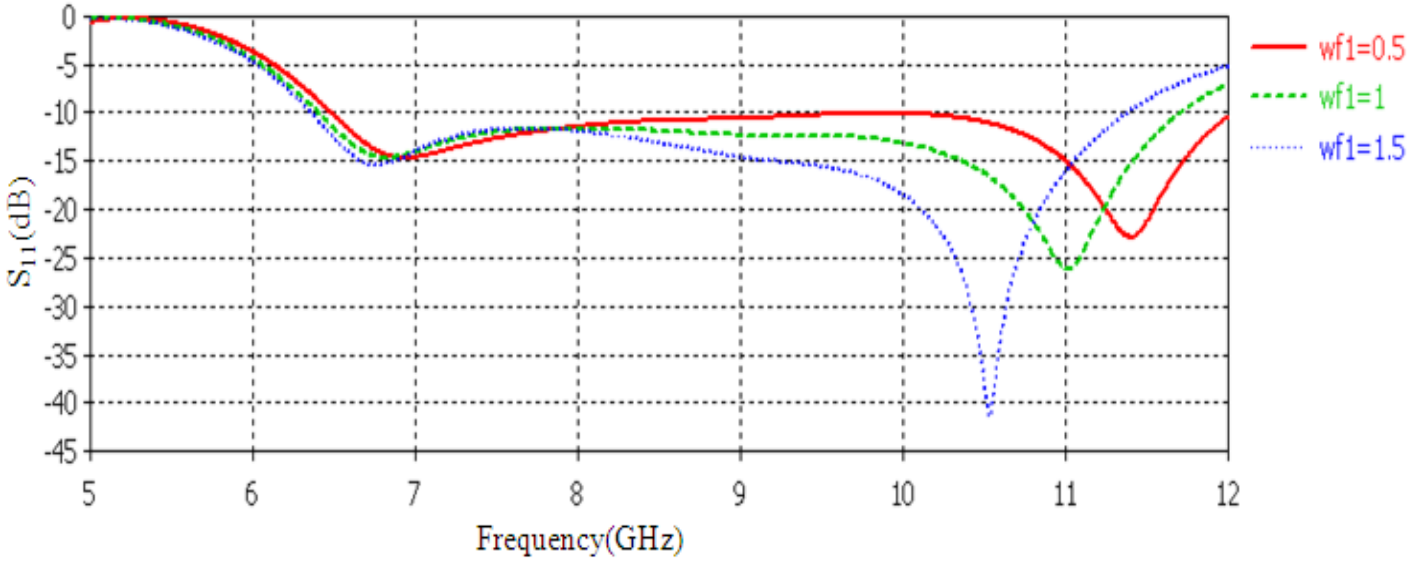
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for various horizontal L-section lengths L_{f2} (4.0-4.75)mm



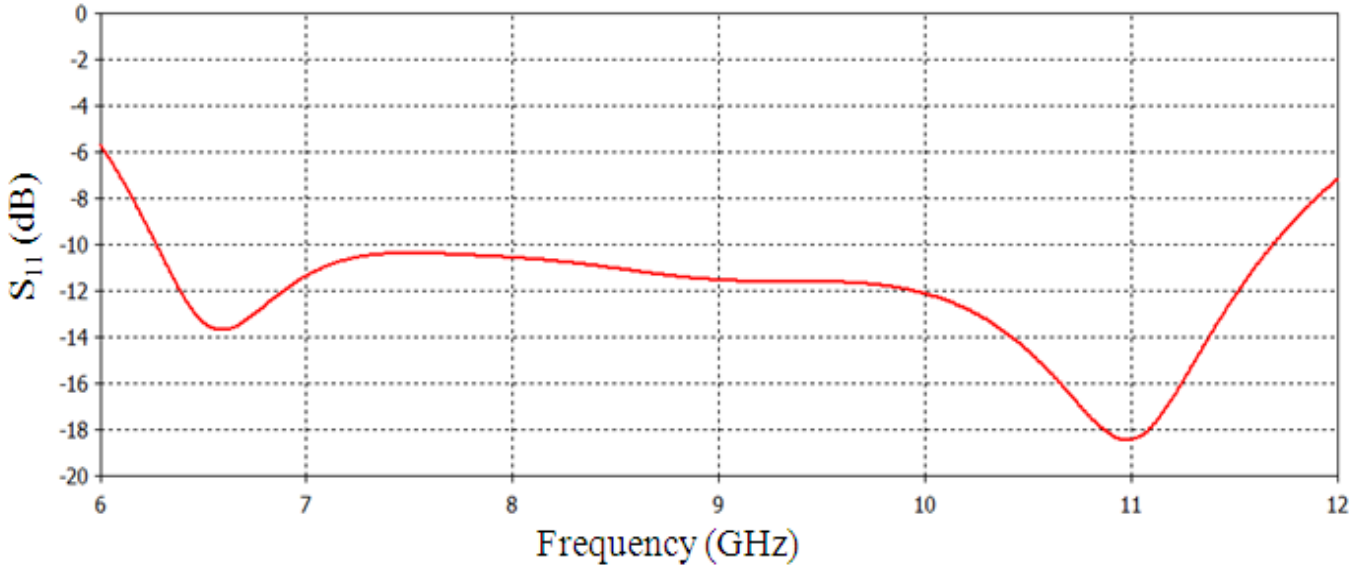
Parametric Study Results(Cont.)

- Simulated reflection coefficient verses frequency for various L-section horizontal widths W_{f1} (0.5-1.5)mm . W_{f1}=1mm is the optimum



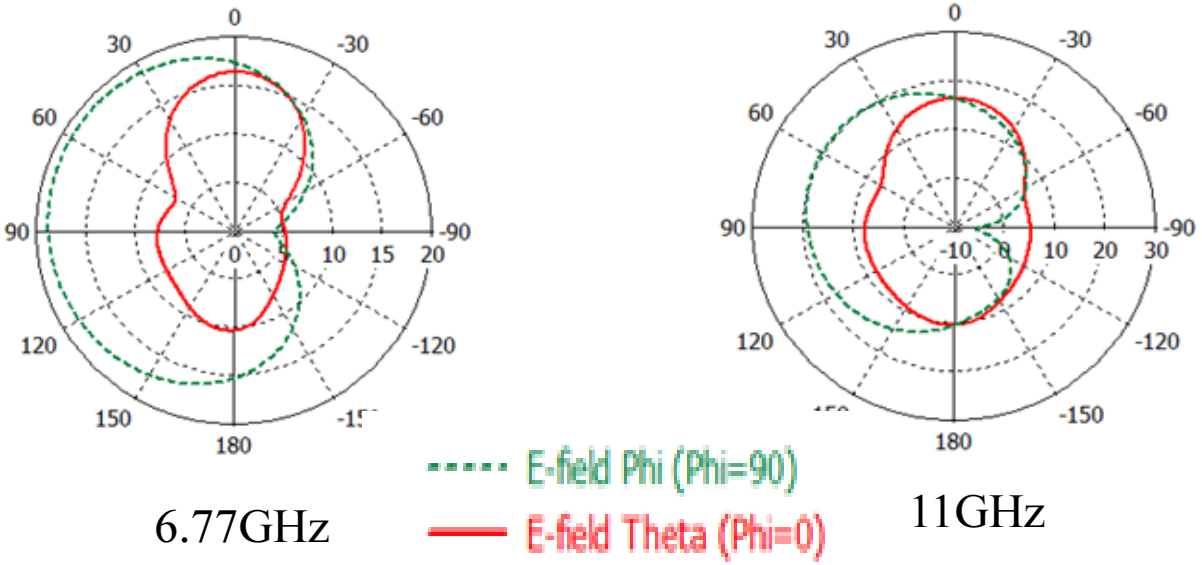
Results And Discussion

- Based on the detailed parametric studies which performed using CST microwave studio suit 2011 , the optimum geometry was simulated and the obtained reflection coefficient characteristics are presented in Figure. It should be noted that 4.0mm, 3.25mm, 0.35mm, 1.25mm, 2.5mm, 1.0mm, 1.25mm, 4.5mm for s_l , y , s_w , x , w_{f2} , l_{f2} and w_{f1} were selected in the design model. As can be seen, the antenna is operating from 6.27 to 11.69 GHz (60%) at the reflection coefficient $|S_{11}|$ better than -10 dB.



Far Field Simulation

- Simulated E-field radiation patterns of the proposed antenna at (Phi=90) and (Phi=0) are shown in figure. Two operating frequencies, i.e. 6.77 GHz and 11.0GHz, were chosen to cover the entire operating band. It is clear from figures that the antenna exhibits broadside radiation.



6.77GHz

11GHz

Conclusions

- The proposed antennas attended to be applied to various applications that covering the ultra wide band frequencies.

- The dielectric resonators used in the proposed antennas are constructed from a low permittivity material with ε_r= 9.4 so as to give a reasonable wide band response.

- Parametric studies have been carried out using three simulation software's to optimize the impedance matching bandwidth for the proposed antennas. The summarized results were very helpful to achieve the required impedance matching and radiation performance that covering several frequency bands.